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Influence of planting geometry and mother plant nutrition on seed yield and quality on parental lines of maize hybrid MAH 14-5

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Abstract

An experiment was conducted at National Seed Project, University of Agricultural Sciences, GKVK, Bangalore during *rabi* 2017-18 to evaluate the influence planting geometry and mother plant nutrition on seed yield and quality of parental lines (Male: CML-451 and female : CAL-1443) of maize hybrid MAH 14-5. The maize parental lines were sown in the field with four fertilizer doses *viz.*, F₁-112.5:70:50 NPKha⁻¹ + 10 kg ZnSO₄, F₂-150:70:50 NPK ha⁻¹ + 10 kg ZnSO₄, F₃-187:70:50 NPK ha⁻¹ + 10 kg ZnSO₄, F₄-225:70:50 NPK ha⁻¹ + 10 kg ZnSO₄ and at four different spacing *viz.*, S₁- 30×20 cm, S₂- 45×20 cm, S₃- 60×20 cm, S₄-60×30 cm. Among the interactions, the highest field emergence in male observed in S₂F₃ (98.7%), plant population S₁F₄ (97.3), plant height S₃F₂ (138.3 cm) at the time of harvest, number of seeds per cob S₃F₂ (138.2), cob weight S₃F₂(138.8 cm), seed weight per cob in S₃F₂ (475.2 gm), seed yield per hectare in S₂F₃ (29.45 q/hac), whereas in case of female highest field emergence was observed in S₃F₁ (97.3%), plant population S₁F₂ (104.3 cm), plant height S₃F₂ (164.5 cm) at the time of harvest, number of seeds per cob S₃F₂ (275.3), cob weight (138.8 cm), seed weight per cob in S₃F₂ (273.2 gm), seed yield per hectare in S₂F₃ (25.96 q/hac). In male, the lowest field emergence in male observed in S₃F₃ (95.7%), plant population S₄F₄ (38.0), plant height S₃F₂ (114.0 cm) at the time of harvest, number of seeds per cob S₃F₂ (138.2), cob weight (138.8 cm), seed weight per cob in S₄F₁ (275.2 gm), seed yield per hectare in S₂F₃ (19.06 q/hac), whereas in case of female lowest field emergence was observed in S₃F₁ (94.3%), plant population S₁F₂ (38.7 cm), plant height S₃F₄ (136.2 cm) at the time of harvest, number of seeds per cob S₃F₁ (217.3), cob weight S₄F₁(207.9 cm), seed weight per cob in S₄F₁ (142.2 gm), seed yield per hectare in S₄F₁ (11.58q/hac).

Keywords: Parental lines, plant height, number of seeds per cob, seed weight per cob, seed yield per hectare

Introduction

Maize (*Zea mays* L.; 2n=20) belongs to family *Poaceae* is one of the important staple food crops of the world and ranks next to wheat and rice. Being a C₄ plant, it is physiologically more efficient and has higher yield potential and wider adaptability to a wide range of environmental conditions. It is referred to as “miracle crop” or the “queen” of cereals. It is the most versatile crop with wide adaptability in varied agro-ecologies. The most contributing factor for its success is the higher genetic yield potential among the food grain crops. The crop is cultivated in different parts of the country throughout the year for various purposes like grain, fodder, green cobs, sweet corn, baby corn, pop corn etc.

In world, maize occupies an area of 176 m.ha. with a production of 863 m.t. and productivity of 4900 kg ha⁻¹. In India maize ranks third position among cereals with the production of 24.17 m. t. Production grown on an area of 9.18 m. ha. with productivity of 2630 kg ha⁻¹ (Anon., 2017) [1].

Planting geometry is the major aspect in economising the parental line and hybrid seed production programme compared to normal grain production. Planting densities have a varying effect on seed yield and quality of crop. There are various factors which are responsible for lower seed yield and inadequate quality of seeds and lack of balanced nutrition. Maize is exhaustive crop and to improve the robustness of plant to get higher yield we need to improve the nutrition of mother plant by applying the optimum level of fertilizer and parental line of hybrids are shy in seed production. Since parental lines of hybrid are isogenic lines they shows weak in morphologically and physically results in lower seed yield and quality.

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Micronutrient deficiencies are usually apparent on the leaves of maize during the development of new tissue at which nutrients are most required. For example, zinc deficiencies indicates broad band of yellowing tissue on one side or both sides of the leaf midrib, symptoms may appear within the first two weeks after sowing, it can overcome by seed treatment with micronutrients. Zinc nutrients are widely used to enhance the yield. Foliar applications of zinc sulphates enhances the uptake and accumulation of nitrogen and finally increases the maize grain yield and also improve starch contents of forage maize (Grzebisz *et al.*, 2008) [3].

The new hybrid MAH 14-5 with parentage of CAL 1443 female parent and CML 451 male parent has a vital importance behind it. First and foremost reason lies in initiating region specific and need specific research. This was a public sector hybrid which has been released at recent past and performed well at farmer's fields of Karnataka assuring greater yield. As this hybrid is having good demand among farmers it is a time to make available genetically pure, high yielding quality seeds to assure farmers with promised yield potential of hybrid and its parents. Hence, it needs standardization of seed production techniques Keeping in view the study was conducted to improve the seed yield of parental line of Maize hybrid MAH 14-5.

Material and methods

The present field experiment on standardization of seed production technologies of parental lines of newly released maize (*Zea mays* L.) hybrid MAH 14-5 was carried out in the Department of Seed Science and Technology, GKVK and National Seed Project, University of Agricultural Sciences, Bengaluru, during *rabi* 2017-18. The details of the materials used and methods adopted during the course of study are described below.

3.2.1 Experimental details

- No. of lines : Two parent lines, CML 451 (Male), CAL 1443 (Female)
- Plot size : 3.0×3.0 m²,
- Design : Factorial RCBD
- Total no. of treatments : 16×3= 48

3.2.2 Treatment details

a) Spacings

- S₁: 30×20 cm
- S₂: 45×20 cm
- S₃: 60×20 cm
- S₄: 60×30 cm

b) Nutritional levels

- F₁: 112.5:70:50 NPKha⁻¹+ 10 kg ZnSo₄
- F₂: 150:70:50 NPK ha⁻¹+ 10 kg ZnSo₄
- F₃: 187:70:50 NPK ha⁻¹+ 10 kg ZnSo₄
- F₄: 225:70:50 NPK ha⁻¹+ 10 kg ZnSo₄

Field emergence (%)

After sowing, seedlings were emerged in each day after 15th days and observation was recorded. The seedling with more than 3 cm in length from the soil surface were recorded and expressed in percentage.

Plant height (cm)

Plant height was measured from base of the plant to the tip of fully opened flag leaf at 30, 45 DAS and at harvest. In each

plot, five plants were selected and mean height was calculated and expressed in centimetre.

Number of leaves per plant

The total number of fully opened green leaves produced per plant was counted manually at 30, 45 days after sowing and at the time of harvest was recorded and expressed in numbers.

Plant population per plot at harvest

The number of plants survived in each plot after the days of maturity were recorded as total plant population at harvest and expressed in numbers.

Number of seeds per cob

The number of seeds per row was counted from each of five cobs and average was expressed as number of seeds per cob.

Seed weight per cob (g)

After shelling the cobs, the seeds were cleaned and reduced to 12 per cent moisture content and weighed individually and the average seed yield of five cobs was expressed in grams.

Seed yield per hectare (q hac⁻¹)

The seed yield per hectare was calculated by utilizing data on seed yield per plot (kg plot⁻¹) and expressed as seed yield in quintal per hectare (q).

Results and discussion

Field emergence (%)

The results of field emergence as influenced by spacing and mother plant nutrition during the seed production are presented in table 1. The field emergence did not differed significantly due to interaction of spacing and mother plant nutrition. in the interaction highest field emergence was observed in S₂F₃ (98.7%) in male and S₃F₁ (97.3%) in female where as lowest was observed in S₃F₃ (95.7%) and S₂F₂ (94.3%) in male and female respectively, due to lesser effect of spacing and mother plant nutrition on early seedling growth stage it was found no much significant differences among the treatments.

Plant population per plot at harvest (No.)

With the effect of spacing and mother plant nutrition interaction the highest plant population was found in S₁F₄ (92.3) and S₁F₂ (104.3) in male and female respectively which was on par with the S₁F₂ (89) in male and S₁F₂ (92.7) in female. Whereas, lowest plant population per plot was recorded in S₄F₄ (38.0) in male and S₄F₁ (38.7) in female. With increase in mother plant nutrition and by decreasing spacing the percent of plant population was increased with enough supply of nutrients and with increased seed rate.

Cob weight (g)

Interaction of spacing and mother plant nutrition on cob weight has showed the non significant difference between treatments. Among the interaction the treatment like S₃F₂ (138.3 g) and S₂F₂ (242 cm) showed the highest cob weight of male and female, respectively. Whereas, the lowest cob weight was noticed in S₄F₁ (126.5) in male and S₄F₁ (207.9 g) in female. This might be due to the more sources to sink ratio there by it help in increased cob weight. The results were accordance with Chandrashekhara (2014) [2] in maize, Mohsin *et al.* (2014) [4] in maize confirmed these results.

Plant height

The data recorded on plant height of female (CAL-1443) and male (CML-451) parent of single cross hybrid maize MAH 14-5 at 30, 60 and 90 DAS (days after sowing) is presented in table 2. With the advancement of crop growth period the highest plant height at the time of harvest was observed in treatment S₃F₂ (138.3 cm) in male and S₃F₂ (164.5 cm) which showed the significant differences among the treatments. Whereas lowest plant height was recorded in treatment S₄F₄ (114.0 cm) in male and in female S₃F₄ (136.2 cm). with increased spacing and proper supply of mother plant nutrition it enhanced the sink to source supply of nutrients which decreased the competition among the plants, and supply of enough amount of nitrogen to maize crop will boost the vegetative growth than with the supply of lesser nitrogen as it is nutrient exhaustive crop.

Number of seeds per cob

The data collected on number of seeds per cob as affected by spacing and mother plant nutrition is presented in table 3. Among parental lines interaction significant difference was observed for number of seeds cob⁻¹ in both male and female. Of the four different spacing and nutrition levels, in male S₃F₂ (138.2) recorded highest number of seeds cob⁻¹ and the lowest was in S₄F₄ (114.6). While in female highest was seen in S₃F₂ (275.3) and lowest in S₃F₁ (217.3). Maize crop supplied with the more spacing and proper mother plant nutrition led to the increased seed set percentage as proper nutrition with less competition for light, nutrients, space has led to increased

seed to ovule ratio leading to increased number of seeds per cob.

Seed weight per cob (g)

The data recorded on seed weight cob⁻¹ is presented in table 3. The seed weight cob⁻¹ was found to be significantly differed for different levels of spacing and mother plant nutrition in both male and female parental lines. Among the treatments, S₃F₂ (475.2 gm) recorded highest seed weight cob⁻¹ and the lowest was in S₄F₁ (275.2 g) of male parent. While, in female parent seed weight cob⁻¹ highest in S₂F₂ (273.2 g) and lowest in S₄F₁ (142.2 g)

Seed yield per hectare (q ha⁻¹)

The data recorded seed yield per hectare as affected by differed spacing and nutrition levels is presented in table 3. The seed yield per hectare was found to be significantly differed for both male and female lines. Among the interactions, S₂F₃ recorded highest seed yield per hectare (29.45 q ha⁻¹) and the lowest was in S₃F₁ (19.06 q ha⁻¹) whereas in female parent highest seed yield per hectare was seen in treatment S₂F₃ (25.96 q ha⁻¹), whereas lowest was seen in S₄F₁ (11.58 q ha⁻¹) followed as represented in table Similar findings also found in Shashibhaskar (2015) [5]. In both the cases of male and female S₂F₃ gave best seed yield per hectare by supplying enough spacing and supplying some extra nutrients to the maize parental lines than the recommended dose has enhanced the growth potential of parental lines as the parental lines weaker in performance.

Table 1: Effect of spacing (S) and fertilizer (F) on field emergence, plant population per plot at harvest and cob weight of parental lines of maize hybrid MAH-14-5.

Treatments	Field emergence (%)		Plant population per plot at harvest (No.)		Cob weight (g)	
	Male	Female	Male	Female	Male	Female
a. Spacing (cm)						
S ₁ : (30×20)	97.3	97.0	87.8	94.5	132.9	228.6
S ₂ : (45×20)	97.5	96.5	70.9	59.6	133.6	229.6
S ₃ : (60×20)	96.8	96.3	54.5	56.6	130.0	236.9
S ₄ : (60×30)	97.5	96.4	41.0	44.3	129.2	219.9
S.Em±	1.5	1.4	0.7	0.8	1.2	3.5
CD (P=0.05)	NS	NS	2.0	2.4	3.3	10.0
b. Fertilizer (NPKha⁻¹+ ZnSo₄)						
F ₁ : (112.5:70:50+10)	98.1	97.5	63.7	62.6	125.1	217.3
F ₂ : (150:70:50 + 10)	97.3	96.3	62.6	67.1	136.0	246.2
F ₃ : (187:70:50 + 10)	97.0	96.3	61.4	66.0	67.3	228.3
F ₄ : (225:70:50 + 10)	96.8	96.2	66.6	59.3	130.4	223.1
S.Em±	1.5	1.4	0.7	0.8	1.2	3.5
CD (P=0.05)	NS	NS	2.0	2.4	3.3	10.0
c. Interaction						
S ₁ F ₁	97.7	97.3	86.7	87.3	128.6	222.2
S ₁ F ₂	98.3	97.7	89.0	93.7	134.3	239.2
S ₁ F ₃	97.0	96.0	83.3	104.3	136.4	228.2
S ₁ F ₄	96.3	97.0	92.3	92.7	132.3	224.9
S ₂ F ₁	98.3	98.0	70.7	67.3	130.0	219.6
S ₂ F ₂	96.0	94.3	63.0	62.0	137.5	242.8
S ₂ F ₃	98.7	96.7	73.3	54.0	134.9	231.7
S ₂ F ₄	97.0	96.7	76.7	55.0	132.1	224.1
S ₃ F ₁	98.3	97.3	54.0	57.0	115.0	218.9
S ₃ F ₂	97.0	95.7	55.0	59.7	138.8	276.2
S ₃ F ₃	95.7	95.7	49.7	61.3	134.5	227.9
S ₃ F ₄	96.0	96.3	59.3	48.3	131.8	224.5
S ₄ F ₁	98.0	97.3	43.3	38.7	126.9	208.6
S ₄ F ₂	97.7	97.0	43.3	53.0	133.5	226.7
S ₄ F ₃	96.3	96.7	39.3	44.3	130.9	225.3
S ₄ F ₄	98.0	94.7	38.0	41.0	125.4	218.9
Diff. levels of S means at the different levels of F						
S.Em±	2.9	2.8	1.4	1.6	2.3	6.9
CD (P=0.05)	NS	NS	4.1	4.7	6.6	20.0
CV (%)	5.20	5.02	5.83	5.43	6.1	6.25

Table 2: Effect of spacing (S) and fertilizer (F) on plant height of parental lines of maize hybrid MAH-14-5.

Treatments	Plant height (cm)					
	30DAS		60DAS		@ Harvest	
Number of DAS	Male	Female	Male	Female	Male	Female
b. Spacing (cm)						
S ₁ : (30×20)	26.0	26.2	80.9	85.7	132.7	155.91
S ₂ : (45×20)	26.5	27.1	76.0	85.5	131.7	153.50
S ₃ : (60×20)	26.3	26.6	72.9	82.8	134.9	148.30
S ₄ : (60×30)	27.3	25.7	74.6	83.5	126.7	149.47
S.Em±	0.4	0.5	1.1	1.2	1.9	2.22
CD (P=0.05)	NS	NS	3.2	NS	5.5	6.34
b. Fertilizer (NPK + ZnSo₄ kgha⁻¹)	Male	Female	Male	Female	Male	Female
F ₁ : (112.5:70:50+10)	26.1	26.3	74.1	84.0	132.2	155.1
F ₂ : (150:70:50 + 10)	26.2	26.1	77.1	85.8	131.8	155.1
F ₃ : (187:70:50 + 10)	27.1	26.9	77.8	85.2	133.7	150.6
F ₄ : (225:70:50 + 10)	26.7	26.3	75.4	82.4	128.4	146.4
S.Em±	0.4	0.5	1.1	1.2	1.9	2.22
CD (P=0.05)	NS	NS	NS	NS	5.5	6.43
d. Interaction	Male	Female	Male	Female	Male	Female
S ₁ F ₁	25.5	26.5	74.9	80.9	133.5	154.9
S ₁ F ₂	25.5	25.7	83.2	86.7	126.5	156.2
S ₁ F ₃	26.9	26.7	88.8	88.1	134.5	156.7
S ₁ F ₄	26.1	25.9	76.6	87.0	136.3	155.9
S ₂ F ₁	26.5	25.7	74.8	89.4	134.1	161.9
S ₂ F ₂	26.5	27.2	74.9	91.1	132.7	161.5
S ₂ F ₃	26.9	28.0	77.2	81.1	131.4	144.7
S ₂ F ₄	26.0	27.5	77.3	80.3	128.6	143.0
S ₃ F ₁	24.7	25.5	71.1	82.6	129.6	146.5
S ₃ F ₂	25.7	26.3	77.5	81.9	138.3	164.5
S ₃ F ₃	27.1	27.4	69.9	85.1	137.0	150.9
S ₃ F ₄	27.5	27.2	73.1	81.6	134.6	136.2
S ₄ F ₁	27.6	27.3	75.6	83.0	131.6	153.9
S ₄ F ₂	27.1	25.3	72.8	83.5	129.5	143.3
S ₄ F ₃	27.3	25.5	75.3	86.6	131.8	150.1
S ₄ F ₄	27.2	24.6	74.7	80.7	114.0	150.5
Diff. levels of S means at the different levels of F						
S.Em±	0.9	0.9	2.2	2.4	3.8	4.5
CD (P=0.05)	NS	NS	6.4	7.1	11.0	12.9
CV (%)	5.79	6.05	5.05	5.02	5.0	5.08

Table 3: Effect of spacing (S) and fertilizer (F) on number of seeds per cob, seed weight per cob, seed yield per plot, seed yield per hectare of parental lines of maize hybrid MAH-14-5.

Treatments	No. of seeds per cob (No.)		Seed weight per cob (g)		Seed yield per hectare (qntls)	
	Male	Female	Male	Female	Male	Female
c. Spacing (cm)						
S ₁ : (30×20)	133.03	229.77	410.1	210.8	24.29	20.87
S ₂ : (45×20)	133.20	229.23	409.9	198.8	25.39	21.53
S ₃ : (60×20)	129.60	235.87	383.7	208.4	23.15	19.64
S ₄ : (60×30)	130.41	219.23	355.7	198.2	22.09	17.84
S.Em±	3.48	8.82	11.03	4.91	0.41	0.41
CD (P=0.05)	NS	NS	31.9	14.2	1.18	1.20
b. Fertilizer (NPK+ ZnSo₄ kgha⁻¹)	Male	Female	Male	Female	Male	Female
F ₁ : (112.5:70:50+10)	125.07	216.73	326.7	169.8	20.44	14.51
F ₂ : (150:70:50 + 10)	135.65	246.57	432.5	230.4	25.46	23.59
F ₃ : (187:70:50 + 10)	134.65	228.40	445.8	227.8	26.53	23.99
F ₄ : (225:70:50 + 10)	130.88	222.40	354.8	188.3	22.49	17.78
S.Em±	3.48	8.82	11.03	4.91	0.41	0.41
CD (P=0.05)	NS	NS	31.84	14.19	1.18	1.20
e. Interaction	Male	Female	Male	Female	Male	Female
S ₁ F ₁	129.53	222.87	372.1	181.7	20.00	17.23
S ₁ F ₂	134.27	242.80	425.1	249.7	26.35	23.77
S ₁ F ₃	136.40	229.20	467	214.3	27.13	24.02
S ₁ F ₄	131.93	224.20	383.3	197.4	23.66	18.44
S ₂ F ₁	129.60	218.87	367.2	181.3	22.04	16.90
S ₂ F ₂	137.00	242.00	449.2	201.1	27.25	24.87
S ₂ F ₃	134.47	232.67	443.2	224.6	29.45	25.96
S ₂ F ₄	131.73	223.40	380	188.3	22.82	18.39
S ₃ F ₁	114.60	217.27	292.1	174	19.06	12.34
S ₃ F ₂	138.27	275.33	457.5	273.2	24.40	23.33

S ₃ F ₃	134.13	227.13	408.1	204.0	26.45	24.31
S ₃ F ₄	131.40	223.73	377.1	192.7	22.70	18.60
S ₄ F ₁	126.53	207.93	275.5	142.2	20.64	11.58
S ₄ F ₂	133.07	226.13	398.3	207.7	23.84	22.39
S ₄ F ₃	133.60	224.60	470	268.3	23.10	21.68
S ₄ F ₄	128.43	218.27	279	174.6	20.79	15.70
Diff. levels of S means at the different levels of F						
S.Em±	6.95	17.64	22.1	9.9	0.82	0.83
CD (P=0.05)	NS	NS	63.7	28.4	2.37	2.39
CV (%)	9.16	13.37	9.80	8.4	7.00	8.19

4. Conclusion

Based on the above discussion it is clear that from the results obtained, it is concluded that sowing of parental lines at different spacing intervals and varying the mother plant nutrition showed the varied results. Among the interaction effect parental lines showed positive response when lines exposed to spacing of 60 X 20 cm supplied with 150:70:50 NPK ha⁻¹+ 10 kg ZnSO₄ showed highest plant height, number of seeds per cob, seed weight per cob and seed yield per plot when compared to other interaction effects.

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